The Role of Climate Change Risk Perception, Response Efficacy, and Psychological Adaptation in Pro-environmental Behavior: A Two Nation Study

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Abstract

As the actions of individuals contribute substantially to climate change, identifying factors that underpin environmentally-relevant behaviors represents an important step towards modifying behavior and mitigating climate change impacts. This paper introduces a sequential model in which antecedent psychological and socio-demographic variables predict climate change risk perceptions, which lead to enhanced levels of response efficacy and psychological adaptation in relation to climate change, and ultimately to environmentally-relevant behaviors. The model is tested and refined using data from large national surveys of Australian and French residents. As hypothesized, in both samples, risk perception (indirectly), response efficacy (both indirectly and directly), and psychological adaptation (directly) predicted behavior. However, these effects were stronger in the Australian than in the French sample, and other unexpectedly strong direct effects were also observed. In particular, subscribing to a "green" self-identity directly predicted all endogenous variables, especially in the French sample. The study provides valuable insights into the processes underlying environmentally-relevant behaviors, while serving as a reminder that effects on behavior may be nation-specific. Strategies are recommended for promoting pro-environmental behavior through the enhancement of a green identity, response efficacy, and psychological adaptation.

Keywords

Climate change; Pro-environmental behavior; Risk perception; Response efficacy; Psychological adaptation; Green self-identity.

Highlights

- A model of climate change precursors to pro-environmental behavior is proposed
- Risk perception, response efficacy, and psychological adaptation are mediators
- The model is tested in large surveys of Australian and French residents
- Following revision, the model fits both national data sets
- Major predictors of pro-environmental behaviors differ between nations.

1.0 Introduction

Most people in Western societies accept the reality of climate change (Borick & Rabe, 2010; Krosnick & MacInnis, 2011; Leviston et al., 2015; Weber & Stern, 2011). Most also accept that human behaviors not only play a key role in causing climate change, but also can contribute to its reduction (Dietz et al., 2009). Scholars have identified many pro- and anti-environmental behaviors, and have sought to understand their antecedents and impacts (Bamberg & Moser, 2007; Gifford & Nilsson 2014; Hines et al., 1987). In this paper, we address the question: To what extent do climate change attitudes and understandings predict pro-environmental behaviors? We focus on three proximate precursors of these behaviors: perceived risks associated with climate change, response efficacy in mitigating these risks, and psychological adaptation to climate change. We argue that by better understanding these antecedent factors, much can be learned, and applied, in the quest for greater environmental sustainability. To this end, we propose a predictive model of the potential antecedents of pro-environmental behavior. We test this and rival models by taking advantage of the opportunity to use data obtained in two previous nationwide surveys. Few past studies have examined the robustness across national boundaries of such a comprehensive, sequential model of pro-environmental behavior. Findings can thus contribute to understanding of the correlates of environmental action and to the ways in which these correlates differ between nations.

1.1 Key Constructs

In this paper, **risk perception** refers to the process of discerning and interpreting signals from diverse sources regarding uncertain events, and forming a subjective judgement of the probability and severity of current or future harm associated with these events (Slovic, 2016; Grothmann & Patt, 2005; Wachinger et al., 2013). **Response efficacy**, also known as perceived instrumentality, refers to a belief that one's actions will be effective, that they will have desired consequences (Spence, Venables, Pidgeon, Poortinga, & Demski, 2010). In accord with the American Psychological Association Task Force (2009) and others (Gifford, Kormos et al., 2011; Moser, 2014; Reser et al., 2012), the construct of **psychological adaptation** captures a suite of interacting cognitive, affective, and motivational processes that involve becoming more attentive to the climate change issue, realizing its reality and implications, adopting a problem-solving attitude, and shifting to a more "pro-environmental" attitudinal and behavioral position. It is a process of sensitisation, (re-)focusing, or (re-)orientation; it implies a willingness to take constructive action, or what van der Linden (2017, p. 26) calls "a general orienting intention to help curb climate change". Central to the concept of psychological adaptation is a process of re-thinking one's stance and one's responses in relation to climate change. Finally, **pro-environmental behaviors** (PEBs) refer to actions, mostly taken at the individual or household level, that benefit the environment or at least harm it as little as possible (Steg & Vlek, 2009).

1.2 Predicting Climate Change Risk Perception

Past research aimed at identifying ways in which to promote PEBs have examined variables that could serve as links in the causal chain to these behaviors. Some such research has shown that risk perceptions, response efficacy, and psychological adjustment are predictive of pro-environmental behaviors (Gifford & Nilsson, 2014; Grothmann & Patt, 2005; Reser et al., 2012; Stern, 2000; van Valkengoed & Steg, 2019; Wachinger et al., 2013). As elaborated below, these three predictors of pro-environmental behaviors can be viewed as operating in a casual sequence, from risk perception through efficacy and adaptation, to behavior. In the current research, we test this indirect effects model, compare this sequence to two possible alternatives, and in so doing add to the relatively small number of the climate change studies that have investigated factors that may unfold sequentially to influence environmental behavior (Zaalberg, Midden, Meijnders, & McCalley, 2009).

In the first stage of our predictive model, we identify factors that underpin perceptions of the risks posed by climate change. Risk perceptions are shaped not only by the objective threat, but also by multiple personal and social factors (Clayton et al., 2015; Slovic, 2016; van der Linden, 2017; Wachinger et al., 2013). To group these variables, we used the categories proposed in van der Linden's (2015) Climate Change Risk Perception Model (CCRPM), a framework that organises predictors of risk perceptions into four categories: cognitive, experiential, socio-cultural, and socio-demographic.

Our model includes two predictor variables that fall within van der Linden's cognitive category. The first is **certainty of belief** in the reality of climate change ("belief certainty"). As this certainty increases, assessment of the threat imposed is likely also to increase. While not necessarily mobilising action, at least a moderately certain belief in climate change would appear to be necessary for contemplation of the risks involved. Research (e.g., Lee et al., 2015; Marlon et al., 2018) confirms the existence of positive associations between climate change beliefs and risk perceptions.

Related to belief certainty, a second cognitive predictor of risk perceptions is factual information and **knowledge** of the science of climate change. Although narrow "knowledge deficit" models have been widely discredited, possession of knowledge of the nature, causes, and impacts of climate change is likely to influence subjective impressions of the risks posed. Consistent with this, research (Milfont, 2012; Shi et al., 2015; Sunblad et al., 2007; van der Linden, 2015; Xie et al., 2019) has found that multiple types of climate change knowledge, particularly when objectively measured, are positively associated with risk perceptions.

We also include in our model two experiential variables, van der Linden's (2015) second broad category of risk perception predictors. Thus, our third predictor is **perceived residential exposure** to the current reality and/or future threat of extreme weather events, natural disasters, and other, often more subtle, manifestations of climate change. This variable gives recognition to the importance of perceptions of and attachments to one's geophysical location and the likely impact one's 'place" has on one's cognitions and affective state. Brody et al. (2008), among others, have found that risk perception is predicted by indices of residential location relative to environmental hazards.

Also within the category of experiential factors, our fourth predictor is **direct personal experience** of natural disasters and extreme weather events. In contrast to the perceived exposure variable, this predictor refers not to perceptions of the vulnerability of one's local environment, but rather to recollections of events actually experienced. While some studies (Marquart-Pyatt et al., 2014; Whitmarsh, 2008) have not found this effect, considerable research (e.g., Akerlof et al., 2012; Carlton et al., 2015; Demski et al., 2017; Frondel et al., 2017; Hamilton-Webb et al., 2017; Lujala et al., 2015; Wachinger et al., 2013; Zaalberg et al., 2009) has confirmed that personal experience of natural disasters and extreme weather events is positively associated with climate change risk perceptions.

Van der Linden (2015) assigns the label sociocultural factors to the third broad category of predictors. Other writers (e.g., Kellsted et al., 2008) refer to a similar set of factors as "ideological and identity" variables. Included in this category are aspects of the social construction and representation of risk, social norms, and the cultural values and worldviews held by individuals embedded in social contexts. Thus, our fifth predictor is the extent to which individuals feel **connected to nature**. Past research (e.g., Devine-Wright, 2013; Gosling & Williams, 2010; Mayer & Frantz, 2004; see also Mackay & Schmitt, 2019) has shown positive associations between connectedness to nature and each of environmental concern and PEBs. Logically, we expect that much of the effect on behavior is carried through increases in risk perceptions that are likely to result when "nature-connected" people observe threats and harm to their natural world.

Sixth, in accord with other writers (e.g., Whitmarsh & O'Neill, 2010), we posit as predictive of perceived risk a sense of oneself as aligned with environmental issues and causes, referred to hereafter as '**green self-identity''**. Substantial evidence regarding the importance of identity-related variables in shaping attitudes and actions (e.g., Babutsidze & Chai, 2018; Clayton & Opotow, 2003; Whitmarsh & O'Neill, 2010) provides grounds for expecting that a green self-identity contributes in unique ways to the prediction of climate change risk perception.

Finally, Van der Linden's (2015) fourth broad category of predictors comprises a set of **sociodemographic** variables. Research indicates that gender, age, and race, and perhaps educational attainment and income, are associated with distinctive patterns of climate change-related cognitions, attitudes, and behaviors (Gifford & Nilsson, 2014; Krosnick et al., 2006; Poortinga et al., 2019; van der Linden, 2015). Van der Linden (2017, p.19) summarizes this literature by stating that "although results vary, there is some evidence for a sociodemographic 'risk profile' where typically younger, female, higher educated, politically liberal, and racial minorities express more concern about climate change."

1.3 Intervening Variables

The model tested in this study can be summarized in four propositions: (1) the six aforementioned psychosocial variables predict levels of climate change risk perception, (2) risk perceptions, and the model's other endogenous variables, vary with sociodemographic factors, (3) risk perception predicts response efficacy and psychological adaptation, and (4) response efficacy and psychological adaptation, in turn, predict PEB. The logic underlying the proposed serial effects to pro-environmental behavior via the exogenous variables, and then risk perception, response efficacy, and psychological adaptation, is that PEB is most likely to be displayed if positively predisposed individuals feel a need (risk perception), feel able (response efficacy), and are willing/ready (psychological adaptation) to do so. The hypothesized model is presented in Figure 1.

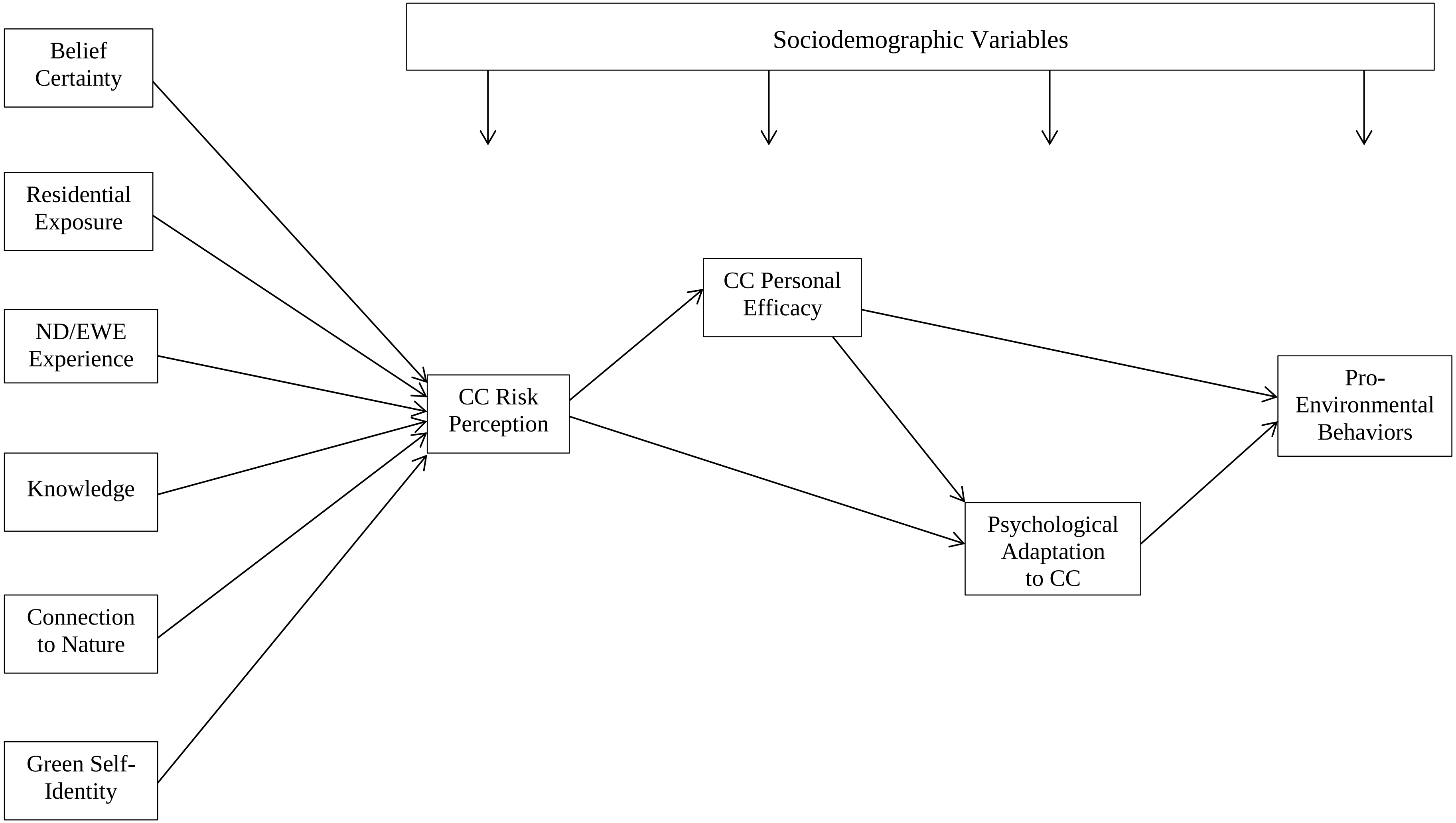

Figure 1. Hypothesized model.

Note: CC = climate change. ND/EWE = natural disaster or extreme weather event.

Both theory and research provide support for indirect, rather than direct, effects on PEB, and, more specifically, for each of the links within the proposed model. Central to this model is the pivotal role play by risk perception as a conduit between the exogenous and subsequent variables. In support, Milfont (2012), in a three-wave longitudinal study, found that climate change concern (a correlate of risk perception) mediated the effect of knowledge on response efficacy, with the data better fitting this model than one in which knowledge had a direct effect on efficacy and a subsequent effect on concern.

Also consistent with the model, research shows that direct associations between risk perception and overt pro-environmental behavior are typically not strong (Bubeck et al., 2012; Frondel et al., 2017; van Valkengoed & Steg, 2019; Wachinger et al., 2013; Weinstein et al., 2000). The discrepancy between perceived risks and behavioral attempts to reduce these risks is an example of the so-called attitude-behavior, or value-action, gap, the size of which varies as a function of a range of intervening variables (Babutsidze & Chai, 2018; Chai et al., 2015; Gifford et al., 2011; Kollmuss & Agyeman, 2002). We propose that response efficacy and psychological adaptation are two variables that intervene within the risk perception-PEB relationship.

The proposition that risk perception is a precondition for response efficacy and psychological adaptation gains support from several social cognitive theories. For example, both cognitive appraisal theory (Lazarus & Folkman, 1984) and protection motivation theory (Rogers, 1983) specify that threat (or primary) appraisal precedes coping (or secondary) appraisal. Risk perception is a central aspect of primary appraisal in that it involves assessing the extent of the threat posed; response efficacy and psychological adaptation, in contrast, represent aspects of subsequent secondary appraisal processes in that they relate to considerations of possible responses to the threat. In support of the temporal priority of risk perceptions, Schwarzer (1992) argues "[a] minimum level of threat or concern must exist before people start contemplating the benefits of possible actions and ruminate their competence to actually perform them" (p. 235).

The hypothesized sequence has parallels in Stern's (2000) Value-Belief-Norm (VBN) theory which proposes that environmental values, beliefs and worldviews (variables that share much in common with green self-identity and other of our antecedent variables) lead to perceptions as to the adverse consequences of valued objects (risk perceptions) which, in turn, lead to perceived ability to effectively reduce the threat (response efficacy) and to a perceived need and sense of responsibility to take environmental actions (components of psychological adaptation). Similarly, Grothmann and Patt's (2005) Model of Private Proactive Adaptation to Climate Change (MPPACC) identifies risk perception, perceived adaptive capacity (a construct similar to response efficacy), and motivational state as important, but largely neglected, psychological steps that lead to environmental action.

Research has provided evidence consistent with these theories and with the current model. Spence et al. (2010), for example, found that both concern/risk perception and perceived instrumentality (or response efficacy) predicted preparedness to reduce energy use (where behavioral preparedness is one facet of psychological adaptation). Geiger, Swim, and Fraser (2017) found that response efficacy predicted willingness to discuss climate change (another indicator of psychological adaptation). Other research has shown that efficacy is related to behavioral willingness (Xie et al., 2019), and that both efficacy (Schutte & Bhullar, 2017) and psychological adaptation (Helm et al., 2018) are positively associated with pro-environmental behavior. That said, the number of prior studies demonstrating the currently proposed relationships between the endogenous variables, and the number of studies examining the status of the psychosocial variables as either direct or indirect predictors of the endogenous variables, are limited. Further empirical examination of these effects is therefore warranted.

1.4 The Current Study

The current research aimed (1) to develop and test a model of the antecedents of pro-environment behaviors and its (psychological) precursors, (2) validate this model in a second independent sample, (3) identify and seek to understand aspects of the model that apply more and less well in the two samples, and (4) use the information and insights thereby gained to recommend structural, psychological, and behavioral intervention strategies aimed at promoting pro-environmental behavior change. We drew on data from two large national surveys, one conducted in Australia (Reser et al., 2012) and one in France (Babutsidze et al., 2018). Availability of these two data sets provided a unique opportunity to test the robustness of our predictive model using individuals who, despite residing in nations on opposite sides of the world, have responded to broadly similar questionnaire items.

There are many similarities between the two nations, but also some important differences. Both countries are westernized democracies in which the majority of citizens enjoy a high standard of living. Research (Lee et al., 2015; Lo, 2016) suggests that residents of both nations are likely to report high levels of climate change awareness and reasonably high levels of climate change action. Compared to Australia, France has a larger population (approximately 67 million versus 25 million inhabitants), and occupies a far smaller area. France has a cooler climate and different climatic/natural disaster threats (more floods, fewer severe droughts and wildfires). In terms of energy sources, France relies more on nuclear power and renewables, whereas Australia relies more on coal. World Bank data (World Bank, 2015) indicate that, compared to a 2014 global average of 4.97 metric tons per capita of CO_2 emissions, Australia emitted 15.4 tons per person whereas France emitted (only) 4.6 tons per person. The two nations can also be compared in terms of past human and financial losses incurred due to climate change. Using the Global Climate Risk Index (Kreft, Eckstein, & Melchoir, 2017), a composite index based on loss of life and money (adjusted for size of population and GDP), over the years 1996 to 2015, France ranked 18th and Australia ranked 34th, of 180 nations. Together, these data suggest that Australia contributes more to global climate change impacts, but its populace suffers less.

The environmental and climate change literatures contain other models of the antecedents of PEB (Klockner, 2013; Gifford et al., 2011; Kollmus & Agyeman, 2002; Stern, 2000) and research examining these models has contributed to knowledge of pro-environmental behavior and the processes that lead to it. Similarly, the current study makes unique and important contributions particularly through its dual-nation scope, its focus on under-researched variables (e.g., psychological adaptation), and its testing of a theoretically-informed and empirically-supported indirect effects model.

2.0 Materials and Methods

2.1 Participants

Institutional ethical approval was obtained for both surveys. The Australian survey was conducted in June and July, 2010, whereas the French survey was conducted in June and July, 2017. Both were anonymous online surveys managed by the same company (Qualtrics) using its panels of nationally representative respondents. Participants were randomly selected to fill quotas based on geographic region and gender in the Australian survey, and based on gender, age, education, residence type, and region, in France. In both nations, checks were in place to ensure data quality and exclude questionnaires that did not meet screening filters before the data sets were forwarded from the provider to the researchers. This left usable questionnaires from 3,096 respondents in the Australian sample and 3,480 respondents in the French sample.

Table 1 provides demographic characteristics of the two samples. As shown, proportions of the two samples were almost identical in respect of gender, but they differed in terms of age and education.

Table 1

Demographic Composition of the Australian and French Samples.

Variable	Value	Australian Sample (N = 3,096)	French Sample (N = 3,480)
Gender	Male	47.0%	47.3%
χ^2 (1) = 0.06	Female	53.0%	52.7%
(*p* = .82)			
Age (years)	< 25	7.8%	15.6%
χ^2 (5) = 102.82	25 to 34	18.6%	19.2%
(*p* < .001)	35 to 44	20.5%	18.4%
	45 to 54	21.5%	18.4%
	55 to 64	19.9%	16.9%
	> 64	11.6%	11.5%
Education	Less than high school	17.9%	16.3%
(highest level	High school diploma	17.1%	27.6%
of attainment)	University/college degree	19.4%	12.1%
χ^2 (4) = 178.12	Higher degree	10.9%	15.6%
(*p* < .001)	Other	34.6%	28.5%
Income	< $AUD40k / <€25k	26.6%	37.7%
(annual	$40k – $80k / €25k - €50k	33.0%	45.1%
household)[a]	$80k – $100k / €50k - €75k	14.8%	12.1%
	$100k – $150k / €75k - €100k	17.5%	3.3%
	$150k - $200k/€100k - €200k	4.3%	1.5%
	> $200k / >200k euros	1.7%	0.3%

[a] Income categories are not equivalent in real terms.

2.2 Measures

In conducting this study, we sought as far as possible to use highly similar measures of the same core variables from the two databases. The full set of items comprising the multi-item scales are given in the online supplemental materials.

Belief certainty. The certainty with which respondents believe in climate change was measured by a single item. In the Australian survey, respondents were asked to indicate their level of agreement on a 5-point Likert scale with the statement "I am certain that climate change is really happening." In France, the question was "How sure are you that climate change is happening?". Response options ranged from 1 = *not at all sure* to 6 = *extremely sure*. For comparison purposes, responses to the Australian item were re-scaled to cover the range 1 to 6. Similar questions have been used to assess belief certainty in past studies (Krosnick, 2008; Krosnick & MacInnis, 2011; Leiserowitz et al., 2018; Spence et al., 2010).

Knowledge. In Australia, 10 questions, and in France six questions, tapped respondents' factual knowledge of the impact of climate change. The items were adapted from those used in past studies (e.g., Sundblad et al., 2007). Four of these items were very similar in the two nations, and were thus chosen to measure respondents' knowledge of the causes and impacts of climate change. A sample pair of items is "Australia produces about 5.5% of the planet's carbon emissions" and "France produces about 4% of the planet's carbon emissions". Response options were *True*, *False*, and *Don't know*. Index measures of climate change knowledge were created by summing all correct responses, and subtracting the number of incorrect ones. (Responses of "don't know" were scored as zero).

Perceived residential exposure. In both national surveys, perceived exposure of one's place of residence to extreme weather events, natural disasters, and other manifestations of climate change was measured by three items. Two of these questions were "How vulnerable do you think your region is to natural disasters (e.g., floods, droughts, cyclones, and bushfires)?” and “How vulnerable do you think the region where you live is to the impacts of climate change?”. The third item asked respondents how close they live to areas frequently affected by extreme weather events or natural disasters. Responses to these items were standardized within the national samples, prior to computing a mean, with higher scores indicating greater perceived residential exposure.

Direct personal experience of natural disasters and extreme weather events. Respondents reported the number of times, if any, they had experienced each of cyclones/storms, bush/wildfires, droughts, floods, and other extreme weather events (up to a maximum of 5 times per event). Reponses were summed across all events for a maximum score of 25, and square-root transformed to reduce skew.

Connection to nature. Respondents in both national surveys completed six items from the Connectedness to Nature scale (Gosling & Williams, 2010), a measure of the extent to which individuals feel part of the natural world. A sample item is “I often feel that I am a part of nature”. Response options ranged from 1 = *strongly disagree* to 6 = *strongly agree,* and were averaged such that higher scores indicate closer connections with nature.

Green self-identity. Participants responded to the 3-item Green Self-Identity Scale (Spence at al., 2010; Whitmarsh & O’Neill, 2010) that assesses the extent to which they self-identified as environmentally-friendly, or “green”. A sample item is “I think of myself as someone who is very concerned with environmental issues”. Response options ranged from 1 = *strongly disagree* to 5 = *strongly agree*. Higher average scores indicated a stronger green self-identity.

Risk perception. All respondents completed Kellstedt et al.’s (2008) 6-item Climate Change Risk Perception Scale. This scale assesses the extent to which respondents perceive climate change to be a risk to their own health, financial status, and environmental welfare (3 items), and to public health, the economy and environmental integrity within their region (3 items). Response options ranged from 1= *strongly disagree/no risk* to 6 = *strongly agree/high risk*. Higher average scores indicated greater perceived risks associated with climate change.

Response efficacy. This self-belief was measured by three climate change-specific items, two from Kellsted et al. (2008) and the third from Spence et al. (2010). A sample item is "I believe that my actions have an influence on climate change." Response options ranged from 1= *strongly disagree* to 6 = *strongly agree*, and were averaged, with higher scores indicating greater confidence in one's capacity to mitigate the impacts of climate change.

Psychological adaptation. In the Australian survey, eight items, and in the French survey, five items, were used to measure psychological adaptation to climate change. Items were developed for the 2010 Australian study (Reser et al., 2012) through a process of pilot testing and scale refinement. Four of these items, all of which tapped into cognitive ('changed thinking') aspects of engagement in the climate change issue, were included in both surveys. An example is "I have changed the way I think about environmental problems because of climate change". Response options ranged from 1 = *strongly disagree* to 6 = *strongly agree*. Higher average scores indicated greater psychological adaptation.

Pro-environmental behavior. Respondents were asked to endorse all behaviors from a list of pro-environmental behaviors that they were currently undertaking to reduce their carbon footprint. The list comprised 15 behaviors in the Australian survey and 14 behaviors in the French survey. Although the behaviors were similar to those included in past studies (Howell, 2014; Spence et al., 2010; Whitmarsh, 2008), only four were common to both of the current surveys. Rather than scoring just these four items, to insure sufficient variability, we computed total scores based on all 15 (Australia) or 14 (France) items. Examples of items included in both surveys are "recycle" and "buy local food or organic food, or grow your own food."

2.3 Overview of the Analyses

Analyses were conducted in six stages. First, the psychometric properties of the multi-item scales were assessed. Second, descriptive statistics and correlations were computed. Third, using just the data obtained from the Australian sample, structural equation modeling (SEM) was used to evaluate the absolute and incremental fit of the hypothesized structural model, and stepwise model revisions were undertaken to improve goodness of fit. Comparisons between these models and two alternative models were also conducted. Fourth, step three was repeated using just the French data set. Fifth, a model that provided acceptable fit in both samples was determined. Finally, analyses assessed the structural invariance of this model across the two national samples, locating sources of similarity and difference between nations.

3.0 Results

3.1 Preliminary Analyses

Prior to conducting the main analyses, checks were performed on the measurement of the core variables. As shown in Table 2, with the possible exception of the 3-item perceived residential exposure scale in the Australian sample (Cronbach's $\alpha = .66$), all multi-item scales had satisfactory levels of internal consistency in both samples ($.74 < \alpha < .94$). Exploratory and confirmatory factor analyses provided evidence of the convergent/divergent validity of the multi-item scales. For example, in both national samples, following Byrne (1998), confirmatory factor analyses of the responses to all items intended to load on any one of the six multi-item scales revealed that the data better fitted the intended six-factor structure than models comprising five or fewer factors.

Descriptive statistics are presented in Table 2. Not surprisingly given the large sample sizes, the differences between Australian and French mean scores on all variables were significant at the $p < .001$ level. On average, French respondents scored higher than the Australians on all ten variables, however, effects sizes were generally small. Correlations are presented in Table 3. As shown, with the exception of education and income in the Australian sample, all variables were significantly correlated with PEB.

Table 2

Descriptive Statistics

	No. of Items	Australian Sample			French Sample			Cohen's *d*
		Mean	SD	α	Mean	SD	α	
Belief Certainty	1	4.53	1.40		4.70	1.20		.13[a]
Perceived Residential Exposure	3	3.73	1.29	.66	3.80	0.75	.82	.06
Natural Disaster/ Extreme Weather Event Experiences	5	1.95	1.16		3.16	4.10		.31
Knowledge	4	1.30	1.96		1.55	1.64		.14[a]
Connection to Nature	6	4.24	1.15	.94	4.51	0.85	.87	.27
Green Self-Identity	3	3.39	0.91	.85	3.55	0.81	.79	.19
Risk Perception	6	3.85	1.18	.90	3.98	0.89	.77	.12
Response efficacy	3	3.83	1.19	.87	4.10	0.88	.81	.26
Psychological Adaptation	4	3.39	1.16	.80	3.88	0.92	.74	.46
Pro-environmental Behavior	15/14	6.43	2.89		7.30	3.05		.31[b]

[a] Comparisons between the means on these variables should be interpreted with some caution because item wordings varied slightly between nations.
[b] Comparisons between these means should be interpreted with considerable caution because items differed between nations.

Table 3

Correlations between Study Variables[ab]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sex		-.15	-.02	-.00	.11	.13	-.05	.14	.10	.15	.16	.16	.14	.09
2. Age	-.11		-.06	-.21	-.14	-.03	.10	-.13	.07	.00	-.16	-.09	-.07	.07
3 Education	-.00	-.18		.25	.08	.02	.07	.02	.09	.08	.06	.08	.09	.08
4 Income	-.11	.06	.31		.02	-.06	-.02	.00	-.09	-.06	-.04	-.02	-.03	-.09
5. Belief Certainty	.02	-.11	.13	.04		.37	.01	.51	.32	.46	.58	.53	.55	.32
6. Perceived Residential Exposure	-.03	.06	.02	.02	.19		.27	.33	.34	.34	.49	.38	.47	.26
7. Natural Disaster/ Extreme Weather Event Experiences	-.05	-.05	.06	.02	.20	.33		-.04	.15	.09	.02	.03	.08	.08
8. Knowledge	-.00	-.04	.03	.01	.26	.15	.18		.24	.34	.51	.42	.47	.28
9. Connection to Nature	.01	.17	.00	-.01	.19	.14	.18	.13		.62	.41	.53	.56	.42
10. Green Self-Identity	-.00	.10	.03	.01	.36	.20	.22	.21	.56		.47	.60	.64	.48
11. Risk Perception	.08	-.08	.03	-.02	.33	.29	.23	.23	.17	.33		.60	.68	.39
12. Response efficacy	.08	-.06	.05	.03	.30	.16	.18	.20	.40	.56	.31		.66	.48
13. Psychological Adaptation	.01	-.09	.06	.04	.34	.22	.25	.23	.41	.60	.40	.53		.50
14. Pro-environmental Behavior	.19	.20	.04	-.01	.24	.14	.13	.11	.36	.45	.22	.36	.32	

[a] Correlations above the diagonal are for the Australia sample; Correlations below the diagonal are for the French sample.

[b] Correlations above $r = .06$ are significant at the $p < .001$ level.

3.2 Structural Equation Modeling

All SEM was performed using maximum likelihood estimation techniques within LISREL 8.80 (Joreskog & Sorbom, 1996). Path modelling, rather than latent variable modelling, was conducted due to the between-nation differences at the measurement level. Model fit was assessed by way of the chi-square statistic (χ^2), although, given the sensitivity of this statistic to sample size, the root mean square error of approximation (RMSEA), comparative fit index (CFI), non-normed fit index (NNFI), and standardized root mean square residual (SRMR) were also used. Benchmarks used to assess good and adequate fit, respectively, were: RMSEA and SRMR: good fit = values < .06, adequate fit = values between .06 and .10; CFI and NNFI: good fit = values > .95; adequate fit = values between .90 and .95 (Byrne, 2010; Hu & Bentler, 1999). Values outside these ranges represent a poor fit. The significance of the difference in the fit of pairs of nested models was assessed via the chi-square difference test ($\Delta\chi^2$).

The first model tested was the hypothesized model (Figure 1) using the Australian data. This model did not provide an adequate fit, χ^2 (19) = 1,699.44 ($p < .001$), RMSEA = .15 (90% confidence interval [CI]: .14, .16), CFI = .94, NNFI = .71, and SRMR = .077. In a series of further model testing, single theoretically-plausible parameters were progressively added to the model based on the modification indices and standardized expected parameter change values (Kaplan, 2000). Thus, in succession, the paths from green self-identity to response efficacy, green self-identity to psychological adaptation, connection to nature to response efficacy, belief certainty to response efficacy, connection to nature to psychological adaptation, green identity to pro-environmental behavior, and belief certainty to psychological adaptation, were added. With these seven paths included, model fit was good, χ^2 (12) = 106.33 ($p < .001$), RMSEA = .050 (90% CI: .042, .059), CFI = 1.00, NNFI = .97, and SRMR = .011. Model modification process was terminated at this point because the value for RMSEA had reached the criterion generally accepted to indicate good fit (.05), and the CFI had attained a value of 1.00, suggesting that further modification might result in over-fitting.

Two reversed-effects models were then tested using the Australian data. Both alternative models included all seven paths that had been added when revising the hypothesized model. In the first alternative model, risk perception leads directly to pro-environmental behavior, which, in turn, leads to response efficacy and psychological adaptation. This model is theoretically plausible from the perspective of self-perception theory (Bem, 1972), which proposes that behaviors occur first, with attitudes and related cognitions (in the current case, regarding response efficacy and readiness to adapt to climate change) inferred subsequently on the basis of observing one's own behavior. Contrary to this contention, the data did not adequately fit this model, χ^2 (13) = 839.42 (p < .001), RMSEA = .14 (90% CI: .13, .14), CFI = .97, NNFI = .79, and SRMR = .033. Although its fit was inferior to that of the revised hypothesized model, $\Delta\chi^2$ (1) = 733.09, it was superior to that of the originally hypothesized model, $\Delta\chi^2$ (6) = 860.02.

The second alternative model specified risk perception and response efficacy as joint initial outcomes of the exogenous variables, with risk perception and response efficacy then leading to psychological adaptation, and ultimately to behavior. This sequence is broadly consistent with Bandura's (1997) social cognitive theory in which the antecedents of efficacy are proposed to include experiential variables (but not risk perceptions). However, this second alternative model also did not provide a good fit on most indices, χ^2 (11) = 387.34 (p < .001), RMSEA = .10 (90% CI: .096, .110), CFI = .99, NNFI = .89, and SRMR = .022. Again, however, the fit was superior to that of the hypothesized model, $\Delta\chi^2$ (8) = 1312.10, yet inferior to revised hypothesized model, $\Delta\chi^2$ (1) = 281.01. Overall, findings pertaining to these alternative models highlight the inadequacy of the originally hypothesized model.

The fit of the French data to the hypothesized model was next assessed, and again, fit of this model was not adequate, χ^2 (19) = 2,338.26 (p < .001), RMSEA = .16 (90% CI: .15, .17), CFI = .86, NNFI = .32, and SRMR = .11. However, the revised Australian model provided a good fit to the French data, with the fit almost as good as for the Australian data, χ^2 (12) = 121.74 (p < .001), RMSEA = .051 (90% CI: .043, .059), CFI = .99, NNFI = .95, and SRMR = .015. This model also fitted the French data better than did either of the two alternative models tested with the Australian data, χ^2 (13) = 302.08 (p < .001), $\Delta\chi^2$ (1) = 178.34, RMSEA = .079 (90% CI: .71, .87), CFI = .98, NNFI = .88, and SRMR = .025, and χ^2 (11) = 181.75 (p < .001), $\Delta\chi^2$ (1) = 60.01, RMSEA = .066 (90% CI: .058, .075), CFI = .99, NNFI = .91, and SRMR = .018, respectively.

Using the French data and starting with the hypothesized model, a process of sequential model modification was then undertaken. Using the same criteria as applied to the Australian data, the first five paths added to the model of the French data were identical to five of the first six additions to the Australian model (the exception was the path from belief certainty to response efficacy). Given that these five additional paths were strongly indicated in both data sets, the hypothesized model, expanded to include these five additional paths, was accepted as the final model.

Fit statistics for this final model, for the Australian data, were χ^2 (14) = 261.5 (p < .001), RMSEA = .07 (90% CI: .07, .08), CFI = .99, NNFI = .94, and SRMR = .019, and, for the French sample, were χ^2 (14) = 155.2 (p < .001), RMSEA = .05 (90% CI: .05, .06), CFI = .99, NNFI = .94, and SRMR = .019. Thus, the fit was slightly better using the French data. Standardized parameter estimates, plus indirect and total effects, for the two samples are shown in Table 4. Figure 2 provides a visual representation of the model, and includes standardized values for the direct effects associated with all but the demographic variables. As shown, variance in the three intervening variables was better explained in the Australian, than in the French, data. Broadly in support of expectations (with one exception: connection to nature, in the French data set), in both samples, all substantive exogenous variables significantly predicted risk perception at the $p < .001$ level. However, contrary to expectations, within this multivariate context, Australians' prior personal experience of extreme weather events and/or natural disasters was *negatively* associated with climate change risk perceptions.

The strongest predictors of risk perception were belief certainty, perceived residential exposure to climate change threats, and, in the French sample only, green self-identity. In the Australian data, as hypothesized, the strongest direct predictor of each of response efficacy and psychological adaptation was risk perception, and the strongest direct predictor of pro-environmental behavior was psychological adaptation. In contrast, green self-identity was the strongest predictor of these variables in the French data. Overall, support was modest for the hypothesis that major effects of the six substantive exogenous variables would be indirect via risk perception. Support for this proposition was stronger in the Australian than in the French sample, and stronger for some variables (e.g., perceived residential exposure) than others (e.g., connection to nature, green self-identity).

Table 4.

Cross-Nation[a] Comparison of Direct, Indirect and Total Effects on the Four Endogenous Variables in the Final Model

Predictor	**Direct Effects**				**Indirect Effects**				**Total Effects**			
	Criterion											
	Risk Percpn.	Response Efficacy	Psych. Adapn.	PEB	Risk Percpn.	Response Efficacy	Psych. Adapn.	PEB	Risk Percpn.	Response Efficacy	Psych. Adapn.	PEB
Gender	.04** *.08****	.05*** *.08****	.00 *-.04***	.00 *.25****	-	.01** *.01****	.03*** *.03****	.02*** *.01****	.04** *.08****	.06*** *.09****	.02 *-.01*	.02 *.26****
Age	-.09*** *-.07****	-.03* *-.11****	.01 *-.12****	.10*** *.23****	-	-.03*** *-.01****	-.05*** *-.04****	-.03*** *-.03****	-.09*** *-.07****	-.06*** *-.12****	-.05*** *-.17****	.08*** *.20****
Education	.01 *-.01*	.02 *-.02*	.00 *-.01*	.06*** *.07****	-	.00 *.00*	.01 *-.01*	.01 *-.00*	.01 *-.01*	.02 *-.02*	.02 *-.02*	.07*** *.07****
Income	-.04** *-.02*	.01 *.06****	.02 *.05****	- .07*** *-.03*	-	-.01** *.00*	-.01* *.01**	.00 *.01****	-.04** *-.02*	.00 *.06****	.01 *.06****	-.06*** *-.01*
Belief Certainty	.31*** *.18****				-	.11*** *.02****	.14*** *.04****	.06*** *.01****	.31*** *.18****	.11*** *.02****	.14*** *.04****	.06*** *.01****
Residential Exposure	.24*** *.18****				-	.08*** *.02****	.11*** *.043****	.04*** *.01****	.24*** *.18****	.08*** .02***	.11*** *.043****	.04*** *.01****
ND/EWE Experiences	-.06*** *.09****				-	-.02*** *.01****	-.03*** *.02****	-.01*** *.00****	-.06*** *.09****	-.02*** *.01****	-.03*** *.02****	-.01*** *.00****
Knowledge	.19*** *.10****				-	.07*** *.01****	.09*** *.02****	.04*** *.00****	.19*** *.10****	.07*** *.01****	.09*** *.02****	.04*** *.00****
Connection to Nature	.13*** *-.03*	.18*** *.14****	.14*** *.11****		-	.05*** *.00*	.10*** *.02****	.11*** *.03****	.13*** *-.03*	.23*** *.13****	.24*** *.13****	.11*** *.03****
Green Self-Identity	.07*** *.21****	.31*** *.46****	.25*** *.38****	.18*** *.31****	-	.03*** *.02****	.10*** *.14****	.16*** *.09****	.07*** *.21****	.34*** *.49****	.35*** *.52****	.34*** *.41****

Risk Perception	.36*** _.10***_	.39*** _.18***_		-	_.07***_ _.02***_	.19*** _.03***_	.36*** _.10***_	.46*** _.20***_	.19*** _.03***_
Response efficacy		.20*** _.21***_	.22*** _.13***_		-	.05*** _.02***_		.20*** _.21***_	.27*** _.14***_
Psychological Adaptation			.24*** _.09***_			-			.24*** _.09***_

Note. CC = climate change. Risk Percepn. = risk perception; Residential Exposure = perceived residential exposure; Psych. Adapn. = psychological adaptation. PEB = pro-environmental behaviors. ND/EWE = natural disaster and extreme weather event. Blank cells indicate the parameter was fixed at zero in this model. Dashes indicate that there was no indirect path from this predictor through this variable.

[a] Standardized parameter estimates are given. The upper number in each cell is from the Australian sample; the lower number (in italics) is from the French sample.

* $p < .05$. ** $p < .01$. *** $p < .001$.

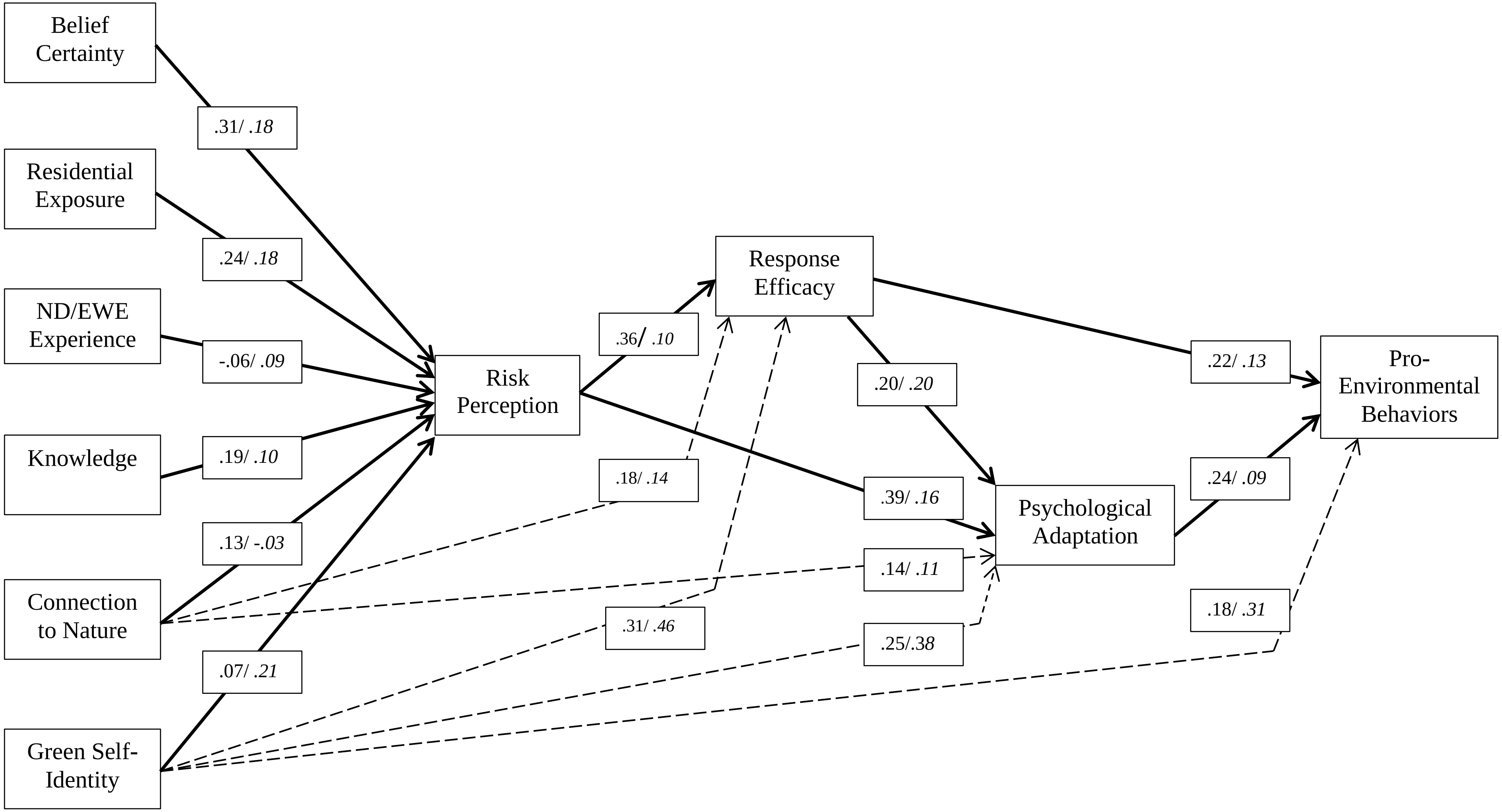

Figure 2. Standardized direct effects in the final model.
(Unbroken lines represent the originally-hypothesized paths. Dashed lines represent paths added to improve model fit. The first number in each cell is from the Australian sample; the second number (in italics) is from the French sample. All effects are significant at the $p < .001$ level, except that from connection to nature to risk perception ($p > .05$) in the French sample. Demographic variables (gender, age, education, and income), and paths leading from them, have been omitted for clarity).

To further explore between-nation differences in the strength of each of the paths, the two data sets were stacked in a single file, and the fit of the final model across both samples was assessed. Results of this multiple group analysis indicated a reasonably good fit when all paths in both samples were freely estimated, χ^2 (28) = 408.7 (*p* < .001), RMSEA = .064 (90% CI: .059, .070), CFI = .99, NNFI = .94, and SRMR = .019. In contrast, with all 32 structural paths leading to the endogenous variables constrained to equality across the two samples, model fit was less satisfactory, χ^2 (60) = 1,394.5 (*p* < .001), $\Delta\chi^2$ (32) = 985.8 (*p* < .001), RMSEA = .082 (90% CI: .078, .086), CFI = .97, NNFI = .91, and SRMR = .038.

In each of a final series of analyses, a single equality constraint was relaxed, starting with the path that had the largest between-sample discrepancy in standardized parameter estimates. In total, ten equality constraints were removed, with each of these modifications improving the fit of the model to the combined samples data. The freed (non-equivalent) paths were: from gender to behavior; from belief certainty to risk perception; from natural disaster experience to risk perception; from connection to nature to risk perception; from green identity to each of risk perception, response efficacy and psychological adaptation; from risk perception to each of response efficacy and psychological adaptation; and from psychological adaptation to behavior. Beyond this, further improvement in model fit did not occur. Model fit after these modifications was good, χ^2 (50) = 561.1 (*p* < .001), RMSEA = .056 (90% CI: .052, .060), CFI = .99, NNFI = .96, and SRMR = .022, although inferior to that of the unconstrained model, $\Delta\chi^2$ (22) = 152.4 (*p* < .001). These analyses thus highlight the existence of between-sample differences in several of the parameter estimates, despite the satisfactory fit of a common model to both samples.

4.0 Discussion

4.1 Review and Explanation of Findings

This study proposed, and tested in two national samples, a model that included predictions of climate change risk perceptions from a suite of cognitive, experiential, sociocultural, and demographic factors, and predictions of pro-environmental behaviors from risk perceptions, response efficacy, and psychological adaptation. Results indicated that most of the hypothesized predictors had significant unique total effects (1) on risk perception (except educational attainment in both samples, and income and connection to nature in the French sample), (2) on response efficacy (except education in both samples and income in the Australian sample), (3) on psychological adaptation (except gender in both samples, education in both samples, and income in the Australian sample), and (4) on PEBs (except gender in the Australian sample and income in the French sample). Of note and as expected, in neither sample did risk perception directly predict pro-environmental behavior. Rather, in both samples, behavior was predicted by risk perception (indirectly only), perceived efficacy (both indirectly and directly), and psychological adaptation (directly). In both data sets, two alternative models that varied the order of pairs of the endogenous variables did not fit as well as the hypothesized model. While the findings thus provide some support for the proposed indirect effects model, the effect sizes of many hypothesized paths were small, additional direct effects improved model fit, and between-nation differences in the strength of many paths were apparent. Below, we highlight and seek to explain some of the more notable and surprising findings

Participants in the French survey had higher average scores than the Australian respondents on all the climate change variables. The French respondents' high scores mirror similar findings in other recent surveys (Poortinga et al., 2018). Many local and global events that occurred either concurrently, immediately prior to, or in the seven-year interval between, the two current surveys could have affected the responses. In part, this could be due to a general worldwide trend over the seven year interval between the Australian and French surveys for people to experience greater concern about climate change. In addition, the French study was conducted during a hotter time of the year, and research (Joiremen et al., 2010; Li et al., 2011; Zaval et al., 2014) indicates that people are more likely to accept the reality of, and risks associated with, climate change on warmer days and months than at other times. In addition, evidence reported in section 1.4 that past climate change-induced human and financial losses have been greater in France than in Australia may have contributed to the higher average level of concern expressed by the current French sample. France's November-December, 2015, hosting of the United Nations Climate Change Conference (COP 21) positioned France as a leader in brokering the first universally binding climate agreement. This may have enhanced public consciousness of the issue, and strengthened risk perceptions and behavioral tendencies. In mid-2017, at about the time the French survey was conducted, the government, under newly elected President Emmanuel Macron, announced steps, including a highly divisive new fuel tax, to hasten the transition towards a more environment-friendly economy.

In contrast, the Australian survey took place in the more immediate aftermath of the 2008 global financial crisis, an event that may have led, at least temporarily, to concerns regarding personal finances overwhelming concerns about climate change (Scruggs & Bengal, 2012). Attempts by the government, the left-leaning Australian Labor Party, to introduce carbon pricing were repeatedly thwarted by powerful interests both within and outside the parliament (legislation introducing a carbon reduction scheme twice failed to gain majority parliamentary support). Although quite volatile, both the political agenda and community opinion at the time were swinging away from climate action (Crowley, 2013).

What appears common to the context of both surveys, however, is that climate change was an important and controversial political issue at the time.

A major finding from the study was that, contrary to predictions, two of the exogenous variables, green identity and connection to nature, had direct effects on the endogenous variables, rather than exclusively indirect effects via risk perception. Indeed, all five paths added to the hypothesized model to form the final model emanated from these two "ideological and identity" variables. In the case of green self-identity, the findings are in accord with recent studies (e.g., Babutsidze & Chai, 2018; Binder & Blankenberg, 2017) that not only show this variable to be predictive of pro-environmental behaviors and lifestyles, but also suggest that these associations result partly from normative and self-presentation concerns. The current findings extend this knowledge by linking green self-identity to response efficacy and psychological adaptation, and suggest that existing theoretical frameworks may be usefully extended to include such an identity-related predictor variable (c.f. Whitmarsh & O'Neill, 2010). In the case of connection to nature, perhaps the effect of this variable gains strength from its partial overlap with unmeasured variables like biospheric values. A question to address in future research is whether the predictive effects of green identity and connection to nature remain as strong in the presence of measures of social norms and values (e.g., Stern, 2000).

A second major finding was that the predictors of pro-environmental behavior differed between the nations: in the Australian sample, risk perception, response efficacy, and psychological adaptation were most strongly linked to this outcome, whereas in the French sample, green self-identity was the strongest predictor. At the risk of over-simplification, it seems that (cognitive) *processing* variables predicted pro-environmental behavior in the former whereas more stable *person-level* variables were most predictive in the latter. The

Australian findings were in accord with expectations, but the findings in the French study were not.

Numerous reasons may be suggested for these discrepant associations. For example, national differences in cultural norms, values, and worldviews may contribute. Some evidence (Caillaud et al., 2019) suggests that climate change is often viewed as a political (rather than a moral) issue in France, a finding that is congruent with the strong effects currently associated with green self-identity. While not claiming that the population of Australia framed the issue in terms of morality, it is worth noting that in the years leading prior the 2010 survey, Prime Minister Kevin Rudd repeatedly referred to climate change as the “great moral challenge of our generation” (e.g., Rudd, 2007, p. 1).

Differences in cultural worldviews may, of course, be amplified by the news media. In analysing international differences in the framing of climate change, Vu et al. (2019) found that news media in countries with relatively low CO2 emissions (in the present case, France rather than Australia) are more likely to portray climate change as a domestic political issue, a bias that might accentuate the impact of green identity as an explanatory variable. Similarly, research (e.g., Xue et al., 2014) has identified links between worldviews and environmental risk perceptions, with individuals who score higher on egalitarianism more likely, and individuals who score higher on individualism and hierarchism less likely, to perceive environmental risks. An empirical question worthy of investigation is the nature and extent of differences along these lines between French and Australian people, and whether any such differences have ‘downstream’ effects on environmental beliefs and behaviors.

Possibly shedding light on the unexpectedly weak relationship between psychological adaptation and PEB in the French sample is the notion that (paradoxically, it may seem) psychological adaptation can actually be “maladaptive” in the sense that greater sensitization to, and engagement in, the climate change issue may give rise to avoidant coping strategies or a degree of unrealistic optimism (Gifford et al., 2011). Such responses would presumably weaken, rather than strengthen, the adaptation-PEB relationship. A possibility to be investigated in future research is that, relative to the Australian sample, the higher mean levels of psychological adaptation in the French sample manifested in greater use of coping strategies that detract from, rather than contribute to, mitigation behaviors.

A further unexpected finding was the weak relationship in the Australian sample between experiences of natural disaster/extreme weather events and each of the endogenous variables. A possible explanation is that adverse experiences promote resilience – the "whatever does not kill us makes us stronger" effect (Seery et al., 2010). This explanation gains some credence from two findings: relative to the French sample, both the mean level of reported experiences of natural disasters, and the correlation between natural disaster experience and response efficacy, were low in the Australian sample.

Some discrepancies between the findings obtained in the two nations may be due to differences in the ways in which variables were operationalized. For example, the pro-environment behavior scale used in the Australian survey included more items pertaining to travel, whereas that used in France contained more items pertaining to domestic tasks. The greater gender difference, favouring females, in PEBs in France may be attributable to these measurement differences, especially if large proportions of the two samples were performing gender-stereotyped roles such that women completed more domestic duties and males completed more roles outside the home.

Given the likelihood of other unmeasured personal and contextual factors affecting behavior (Gifford et al., 2011; Steg & Vleck, 2009), the current model's performance in accounting for 33% (Australia) and 32% (France) of the variance in pro-environmental behaviors is quite acceptable in light of other considerations, such as: (1) PEBs may be performed for financial, health, and other reasons that are unrelated to "environmental" considerations (hence, “environmental” variables are unlikely to account for them); (2) due to conscious (e.g., trying to “fake good”) or unconscious errors (e.g., recall lapses), PEBs and its predictors are imperfectly measured through self-reports (Gifford et al., 2011; Weinstein, 1989); and (3) there was a lack of measurement correspondence between the predictors and behavior, with the measures of the predictors pertaining to the global phenomenon and existential threat of climate change whereas the behaviors were more specific, local, and mundane. Importantly, and not to be overlooked, climate change response efficacy and psychological adaptation are important outcomes in their own right, and effects on these ‘issue-engagement’ variables were considerably stronger than those on behavior.

The current research shares some features with the recent cross-sectional, Australian study by Xie et al. (2019). In contrast to the current work, that study set out to test and extend the CRPMM using van der Linden’s (2015) survey instrument to measure most variables. Xie et al. found that, while a measure of affect was the strongest single predictor of risk perception, personal experience, response knowledge and mitigation response inefficacy were also significant. As was the case in the present study, variables that predicted behavior (in their case, behavioral willingness) included personal experience, (response) knowledge, mitigation response (in)efficacy, and participant age, as well as risk perception. Together, the two studies complement each other, with Xie et al. showing strong effects associated with affect, values and efficacy variables, whereas the current study demonstrated that green self-identity and psychological adaptation, in particular, are additional potentially important predictors of pro-environmental behaviors.

4.2 Evaluation and Implications of the Study

Major strengths of this study include the large, representative samples from two nations, the use of very similar, and for the most part highly reliable, measurement scales, and the testing and cross-validation of a novel, theory-based model of the sequenced antecedents of pro-environmental behavior. Major limitations include the use of a cross-sectional research design and self-report measures. The strong associations between several pairs of variables (e.g., green self-identity and pro-environmental behavior) may be partly attributable to the operation of response consistency effects. Content validity of some variables was compromised by attempts to seek measurement parity across surveys: for example, the efficacy items assessed response-efficacy but not self-efficacy, and the psychological adaptation items pertained to cognitive, but not to other, aspects of adaptation. The model itself has weaknesses in its overly-simplistic depiction of linear, unidirectional, and non-interactional relations. The existence of other, equivalent-fitting models – ones that possibly extend the previously described alternative models – cannot be discounted. Longitudinal studies are required to assess temporal and reciprocal relations between the focal variables. The model could be strengthened by including additional cognitive (e.g., heuristics and biases), experiential (e.g., media exposure), socio-cultural (e.g., descriptive and prescriptive social norms), and sociodemographic predictors (e.g., political party affiliation). Arguably, the model lacks sufficient emphasis on affective dimensions of the focal variables (e.g., "risk-as-feelings"), although each of perceived residential exposure, direct experience, connectedness to nature, and green self-identity has an affective connotation (Gosling & Williams, 2010; van der Linden, 2015).

Findings confirm the utility of van der Linden's (2015) framework to understand the precursors to climate change risk perception. The study also provides evidence of the extent to which predictors of climate change attitudes and behaviors may vary between samples, even when these variables are measured in similar ways. This observation draws attention to the possibility that findings from past studies regarding the antecedents of PEB, and other environmental outcomes, might also be sample- and/or nation-specific. A clear recommendation that follows is that new and important findings require replication in different national and cultural contexts (Lee et al., 2015).

Many approaches have been proposed and tested to promote pro-environmental behavior. These approaches variously emphasize engineering, educative, economic, and enforcement solutions (Gifford et al., 2011). Findings from the current research are most obviously applied within the context of education-based interventions. For example, the findings reinforce the contribution of response efficacy to PEB, and hence the potential value of attempts to enhance efficacy by educating people as to ways in which they can purchase environmentally-friendly goods and services, and effectively use and re-use them once purchased. Emphasis should be placed on behaviors that have a high impact on greenhouse gas emissions such as reducing food waste through composting, shifting to more plant-rich diets, and installing roof-top solar panels (Hawken, 2017; Stern, 2011). Educative strategies can also be employed to enhance psychological adaptation, with sensitization to the issue and engagement in preventative and protective action enhanced in schools and through mass media campaigns. Whereas strategies targeting risk perception, response efficacy and psychological adaptation may be effective especially in Australians, other strategies, ones that aim to foster the cultivation of a green self-identity, may be a more efficacious way in which to increase PEBs in France. Of the many strategies that might be applied to facilitate shifts in ideology and self- identity, broadcasting of pro-environmental cues by political and community elites may be especially effective (Brulle et al., 2012).

References

Akerlof, K., Maibach, E. W., Fitzgerald, D., Cedeno, A. Y., & Neuman, A. (2013). Do people "personally experience" global warming, and if so how, and does it matter? *Global Environmental Change, 23,* 81-91. doi: 10.1016/j.gloenvcha.2012.07.006

American Psychological Association Task Force on the Interface between Psychology and Global Climate Change (2009). *Psychology and global climate change: Addressing a multi-faceted phenomenon and set of challenges*. Retrieved from http://www.apa.org/science/about/publications/climate-change.aspx

Babutsidze, Z., Bradley, G., Chai, A., Dietz, T., Hales, R., Markowitz, E., & Nesta, L. (2018). Public perceptions and responses to climate change in France: Research report. Nice, France: Université Côte d'Azur.

Babutsidze, Z., & Chai, A. (2018). Look at me saving the planet! The imitation of visible green behavior and its impact on the climate action-value gap. *Ecological Economics, 146*, 290-303. doi: 10.1016/j.ecolecon.2017.10.017

Bamberg, S., & Moser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behavior. *Journal of Environmental Psychology*, *27*, 14-25. doi: 10.1016/j.envp.2006.12.002

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman: New York.

Bem, D. J. (1972). Self-perception theory. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 6, pp. 1-62). New York: Academic Press.

Binder, M., & Blankenberg, A. K. (2017). Green lifestyles and subjective well-being: More about self-image than actual behavior? *Journal of Economic Behavior & Organization*, *137*, 304-323. doi: 10.1016/jebo.2017.03.009

Borick, C. P., & Rabe, B. G. (2017). Personal experience, extreme weather events, and perception of climate change. In H. von Storch (Ed.), *Oxford research encyclopedia of climate science.* doi: 10.1093/acrefore/9780190228620.013.311

Brody, S. D., Zahran, S., Vedlitz, A., & Grover, H. (2008). Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. *Environment and Behavior, 40,* 72-95. doi: 10.1177/0013916506298800

Broomell, S. B., Budescu, D. V., & Por, H-H. (2015). Personal experience with climate change predicts intentions to act. *Global Environmental Change, 32,* 67-73. doi:10.1016/j.gloenvcha.2015.03.001

Brulle, R. J., Carmichael, J., & Jenkins, J. C. (2012). Shifting public opinion on climate change: An empirical assessment of factors influencing concern over climate change in the U.S., 2002-2010. *Climatic Change, 114,* 169-188. doi: 10. 1007/s10584-012-0403-y

Bubeck, P., Botzen, W. J. W., & Aerts, C. J. H. (2012). A review of risk perceptions and other factors that influence flood mitigation behavior. *Risk Analysis, 32*, 1481-14-95. doi:10.1111/j.1539-6924.2011.01783.x

Byrne, B. M. (1998). *Structural equation modelling with LISREL, PRELIS and SIMLIs: Basic concepts, applications, and programming.* Mahwah, NJ: Erlbaum.

Caillaud, S., Krauth-Griber, S., & Bonnot, V. (2019). Facing climate change in France and Germany: Different emotions predicting the same behavioral intentions? *Ecopsychology*, *11,* 49-58. Doi: 10.1089/eco.2018.0060

Carlton, J. S., Mase, A. S., Knutson, C. L., Lemos, M. C., Haigh, T., Todey, D. P. & Prokopy, L. S. (2016). The effects of extreme drought on climate change beliefs, risk perceptions, and adaptation attitudes. *Climatic Change, 135*, 211-226. doi: 10.1007/s10584-015-1561-5

Chai, A., Bradley, G. L., Lo, A., & Reser, J. (2015). What time to adapt? How discretionary time contributes to the value-action gap. *Ecological Economics, 116*, 95-107. doi: 10.1016/j.ecolecon.2015.04.013

Clayton, S., Devine-Wright, P., Stern, P.C., Whitmarsh, L., Carrico, A., Steg, L., Swim, J., & Bonnes, M., (2015). Psychological research and global climate change. *Nature Climate Change, 5*, 640-646. doi: 10.1038/NCLIMATE2622

Clayton, S., & Opotow, S. (2003). *Identity and the natural environment*. Cambridge, MA: MIT Press

Crowley, K. (2013). Pricing carbon: The politics of climate policy in Australia. *WIRES Climate Change, 4,* 603-613. doi:10.1002/wcc.239

Demski, C., Capstick, S., Pidgeon, N., Sposato, R. G., & Spence, A. (2017). Experience of extreme weather affects climate change mitigation and adaptation responses. *Climatic Change, 140*, 149-164. doi: 10.1007/s10584-016-1837-4

Devine-Wright, P. (2013). Think global, act local? The relevance of place attachments and place identities in a climate changed world. *Global Environmental Change, 23,* 61-69 doi: 10.1016/j.gloenvcha.2012.08.003

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *PNAS, 106* (44), 18452-18456. doi: 10.1073.pnas.0908738106

Frondel, M., Simora, M., & Sommer, S. (2017). Risk perception of climate change: Empirical evidence from Germany. *Ecological Economics*, *137,* 173-183. doi:10.1016/j.ecolecon.2017.02.019

Geiger, N., Swim, J., & Fraser, J. (2017). Creating a climate for change: Interventions, efficacy and public discussion about climate change. *Journal of Environmental Psychology, 51,* 104-116. doi: 10.1016/j.envp.2017.03.101

Gifford, R., Kormos, C., & McIntyre, A. (2011). Behavioral dimensions of climate change: Drivers, responses, barriers, and interventions. *WIREs Climate Change*, *2*, 801-827. doi: 10.1002/wcc.143

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behavior: A review. *International Journal of Psychology, 49*, 141-157. doi: 10.1002/ijop.12034

Gosling, E., & Williams, K. J. H. (2010). Connectedness to nature, place attachment and conservation behavior: Testing connectedness theory among farmers. *Journal of Environmental Psychology, 30*, 298-304. doi: 10.1016/j.envp.2010.01.005 doi: 10.1016/j.envp.2010.01.005

Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, *15*, 199-213. doi: 10.1016/j.gloenvcha.2005.01.002

Hamilton-Webb, A., Naylor, R., Manning, L., & Conway, J. (2017). The relationship between risk experience and risk response: A study of farmers and climate change. *Journal of Risk Research*, doi: 10.1080/13669877.2016.1153506

Hawken, P. (Ed.). *Drawdown: The most comprehensive plan ever proposed to reverse global warming*. New York: Penguin

Helm, S. V., Politt, A., Barnett, M. A., Curran, M. A., & Craig, Z. R. (2018). Differentiating environmental concern in the context of psychological adaption to climate change. *Global Environmental Change, 48*, 158-1567. doi: 10.1016/j.gloenvcha.2017.11.012

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education, 18*, 1-8.

Howell, R. A. (2014). Investigating the long-term impacts of climate change communications on individuals' attitudes and behavior. *Environment and Behavior, 46*, 70-101. doi: 10.1177/0013916512452428

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Joireman, J., Truelove, H. B., & Duell, B. (2010). Effect of outdoor temperature, heat primes and anchoring on belief in global warming. *Journal of Environmental Psychology, 30*, 358-367. doi: 10.1016/j.jenvp.2010.03.004

Joreskog, K. G., & Sorbom, D. (1996). *LISREL 8: User's reference guide.* Chicago, Illinois: SSI Scientific Software.

Kaplan, D. (2000). *Structural equation modelling: Foundations and extensions*. Thousand Oaks, CA: Sage.

Kellstedt, P. M., Zahran, S., & Vedlitz, A. (2008) Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis*, *28*, 113-126. doi: 10.1111/j.1539-6924.2008.01010.x

Klockner, C. A. (2013). A comprehensive model of the psychology of environmental behavior - A meta-analysis. *Global Environmental Change*, 23, 1028-1038. doi: 10.1016/jgloenvcha.2013.05.014

Kollmus, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research, 8*(3), 239-260. doi: 10.1080/1350462022014540 1

Kreft, S., Eckstein, D., & Melchoir, I. (2017). *Global Climate Risk Index 2017*.Retrieved from https://germanwatch.rog/en/download/16411.pdf

Krosnick, J. (2008). *Fuel costs boost conservation efforts: 7 in 10 reducing 'carbon footprint'*. ABC News/Planet Green/Stanford poll. Retrieved from http://krosnick.socialpsychology.org

Krosnick, J., Holbrook, A., Lowe, L., & Visser, P. (2006). The origins and consequences of democratic citizens' policy agendas: A study of popular concern about global warming. *Climatic Change, 77*, 7-43. doi: 10.1007/s10584-006-9068-8

Krosnick, J. A., & MacInnis, B. (2011). *National survey of American public opinion on global warming*. Stanford, CA: Stanford University with Ipsos and Reuters.

Lang, C., & Ryder, J. D. (2016). The effect of tropical cyclones on climate change engagement. *Climatic Change*, *135*, 625-638. doi: 10.1007/s10584-015-1590-0

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal and coping*. New York: Springer.

Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C. Y., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature Climate Change, 5*, 1014-1023

Leiserowitz, A., Maibach, E., Rosenthal, S., Kotcher, J., Ballew, M., Goldberg, M., & Gustafson, A. (2018). *Climate change in the American mind: December 2018*. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication.

Leviston, Z., Greenhill, M., & Walker, I. (2015). *Australian attitudes to climate change: 2010-2014*. Fremantle, Western Australia: CSIRO.

Li, Y., Johnson, E. J., & Zaval, L. (2011). Local warming: Daily temperature change influences belief in global warming. *Psychological Science, 22*, 454-459. doi: 10.1177/0956797611400913

Lo, A. (2016). National income and environmental concern: Observations from 35 countries. *Public Understanding of Science, 25*, 873-890. doi: 10/1177/0963662515581302

Lujala, P., Lein, H., & Rød, J. K. (2015). Climate change, natural hazards, and risk perception: The role of proximity and personal experience. *Local Environment, 20,* 489-509. doi: 10.1080/13549839.2014.887666

Mackay, C. M. L., & Schmitt, M. T. (2019, online). Do people who feel connected to nature do more to protect it? A meta-analysis. *Journal of Environmental Psychology, 65*. doi: 10.1016/j.envp.2019.101323

Marlon, J. R., van der Linden, S., Howe, P. D., Leiserowtiz, A., Woo, S. H., & Broad, K. (2018). Detecting local environmental change: The role of experience in shaping risk judgments about global warming. *Journal of Risk Research,* doi: 10.l1080/13669877.2018.1430051

Marquart-Pyatt, S. T., McCright, A. M., Dietz, T., & Dunlap, R. E. (2014). Politics eclipses climate extremes for climate change perceptions. *Global Environmental Change, 29*, 246-257. doi: 10.1016/j.gloenvcha.2014.10.004

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individual's feelings in community with nature. *Journal of Environmental Psychology, 24*, 503-515.

Milfont, T. L. (2012). The interplay between knowledge, perceived efficacy, and concern about global warming and climate change: A one-year longitudinal study. *Risk Analysis, 32*, 1003-1020. doi: 10.1111/j.1539-6924.2012.01800.x

Moser, S. C. (2014). Communication adaptation to climate change: The art and science of public engagement when climate change comes home. *WIREs Climate Change*, *5*, 337-358. doi: 10.1002/wcc.276

Poortinga, W., Fisher, S., Böhm, G., Steg, L., Whitmarsh, L., & Ogunbode, C. (2018). *European attitudes to climate change and energy: Topline results from Round 8 of the European Social Survey*. London: European Social Survey ERIC.

Poortinga, W., Whitmarsh, L., Steg, L., Böhm, G., & Fisher, S. (2019). Climate change perceptions and their individual-level determinants: A cross-European analysis. *Global Environmental Change, 55*, 25-35. doi: 10.1016/j.gloenvcha.2019.01.007

Reser, J. P., Bradley, G. L., & Ellul, M. C. (2012). Coping with climate change: Bringing psychological adaptation in from the cold. In B. Molinelli & V. Grimaldo (Eds.), *Handbook of the psychology of coping: Psychology of emotions, motivations and actions* (pp. 1-34). New York, NY: Nova Science.

Reser, J. P., Bradley, G. L., Glendon, A. I., Ellul, M. C., & Callaghan, R. (2012). *Public risk perceptions, understandings and responses to climate change in Australia and Great Britain*. Gold Coast, Qld: Griffith Climate Change Response Adaptation Facility. Retrieved from http://www.nccarf.edu.au/publications/public-risk-perceptions-final

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J. R. Cacioppo & R. E. Petty (Eds.), *Social psychology: A source book* (pp. 153-176). New York: Guilford Press.

Rudd, K. (2007). Opening remarks at the National Climate Change Summit, Canberra, 31st March, 2007: Climate Change: Forging a New Consensus. Available at: https://parlinfo.aph.gov.au/parlInfo/download/media/pressrel/H4OM6/upload_binary/h4om62.pdf

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In R. Schwarzer (Ed.), *Self-efficacy: Thought control of action* (pp. 217-243). Washington DC: Hemisphere.

Schutte, N. S., & Bhullar, N. (2017). Approaching environmental sustainability: Perceptions of self-efficacy and sustainability. *Journal of Psychology: Interdisciplinary and Applied, 151*, 321-333. doi: 10.1080/00223980.2017.1289.144

Scruggs, L., & Benegal, S. (2012). Declining public concern about climate change: Can we blame the great recession? *Global Environmental Change*, *22*, 505-515. doi: 10.1016/j.gloenvcha.2012.01.002

Seery, M. D., Holman, E. A., & Silver, R. C. (2010). Whatever does not kill us: Cumulative lifetime adversity, vulnerability, and resilience. *Journal of Personality and Social Psychology*, *99*, 1025-1041. doi: 10.1037/a0021344

Shi, J., Visschers, V.H.M., & Siegrist, M. (2015). Public perception of climate change: The importance of knowledge and worldviews. *Risk Analysis*, *35*, 2183-2201. doi: 10.1111/risa.12406

Slovic, P. (2016). Understanding perceived risk: 1978-2015. *Environment: Science and Policy for Sustainable Development*, *58*, 25-29. doi:10.1080.00139157.2016.1112169

Spence, A., Venables, D., Pidgeon, N., Poortinga, W., & Demski, C. (2010). *Public perceptions of climate change and energy futures in Britain*. Cardiff, UK: Understanding Risk Research, Cardiff University.

Steg, L., & Vleck, C. (2009). Encouraging pro-environmental behavior: An integrative review and research agenda. *Journal of Environmental Psychology, 29*, 309-317. doi:10.1016/j.envp.2008.10.004

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*, 407-424.

Stern P. C. (2011). Contributions of psychology to limiting climate change. *American Psychologist, 66*, 303-314.doi: 10.1037/a0023235

Sundblad, E-L., Biel, A., & Gärling, T. (2007). Cognitive and affective risk judgments related to climate change. *Journal of Environmental Psychology*, *27*, 97-106. doi: 10.1016/j.envp.2007.01.003

Tranter, B., & Booth, K. (2015). Scepticism in a changing climate: A cross-national study. *Global Environmental Change, 33*, 154-164. 10.1016/j/gloenvcha.2015.05.003

van der Linden, S. (2015). The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. *Journal of Environmental Psychology, 41*, 112-124. doi: 10/1016/j.jenvp.2014.11.012

van der Linden, S. (2017). Determinants and measurement of climate change risk perception, worry, and concern. In H. von Storch (Ed.), *Oxford research encyclopedia of climate science.* doi: 10.1093/acrefore/9780190228620.013.318

Van Valkengoed, A. M., & Steg, L. (2019). Meta-analyses of factors motivating climate change adaptation behavior. *Nature Climate Change*, *9*, 158-163. doi: 10.1038/s41558-018-0371-y

Vu, H. T., Liu, Y., & Tran, D. V. (2019). Nationalizing a global phenomenon: A study of how the press in 45 countries and territories portrays climate change. *Global Environmental Change, 58*. doi: 10.1016/j,gloenvcha.2019.101942

Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox – implications for governance and communication of natural hazards. *Risk Analysis*, *33*, 1049-1065. doi: 10.1111.j.1539-6924-2012-01942.x

Weber, E. U., & Stern, P. C. (2011). Public understandings of climate change in the United States. *American Psychologist*, *66*, 315-328. doi: 10.1037/a0023253

Weinstein, N. D. (1989). Effects of personal experience on self-protective behavior. *Psychological Bulletin*, *105*, 31-50.

Weinstein, N. D., Lyon, J. E., Rothman, A. J., & Cuite, C. L. (2000). Preoccupation and affect as predictors of protective action following natural disaster. *British Journal of Health Psychology*, *5*, 351-363.

Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioral response. *Journal of Risk Research, 11,* 251-374. doi: 10.1080/13669870701552235

Whitmarsh, L., & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviors. *Journal of Environmental Psychology, 30,* 305-314. doi: 10.1016/j.envp.2010.01.003

World Bank (2015). Co_2 emissions – Metric tons per capita. Retrieved 03.06.2018 from http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

Xie, B., Brewer, M. B., Hayes, B. K., McDonald, R. I., & Newell, B. R. (2019, online). Predicting climate change risk perception and willingness to act. *Journal of Environmental Psychology, 65*. doi: 10.1016/j.envp.2019.101331

Xue, W., Hine, D. W., Loi, N. M., Thorsteinsson, E. B., & Phillips, W. J. (2014). Cultural worldviews and environment risk perceptions: A meta-analysis. *Journal of Environmental Psychology, 40,* 249-258. doi: 10.1016/jenvp.2014.07.002

Zaalberg, R., Midden, C., Meijnders, A., & McCalley, T. (2009). Prevention, adaptation, and threat denial: Flooding experiences in the Netherlands. *Risk Analysis, 29,* 1759-1778. doi: 10.1111/j.1539-6924.2009.01316.x

Zaval, L., Keenan, E. A., Johnson, E. J. & Weber, E. U. (2014). How warm days increase belief in global warming. *Nature Climate Change, 4,* 143-147. doi: 10.1038/NCLIMATE2093